BUILDING A REGIONAL GEOGRAPHIC DATA NETWORK

Abstract

This paper describes a multi-agency, cooperative project, designed to enable seamless, real-time data transport among more than 25 public agencies in the greater Houston, Texas region. Focused on the transfer of geographic data, the foundation for the initiative is the prior, successful development and adoption of a common, regional base map, created through the collaboration and support of members of the region's Geographic Data Committee. The map, as a common geo-reference, became the vehicle for creating compatible geographic data sets. This new project, employing Tadpole Cartesia's ***GO! Sync*** *product, is enabling the basemap's subscribers to exchange and replicate each other's data resources, in real time, across organizations and across the region, without the expense of a dedicated, high speed telecommunications backbone.*

PART I

ORGANIZATIONAL BACKGROUND AND PROJECT OVERVIEW

Contributed by Max Samfield, H-GAC Data Services Director

The Houston-Galveston Area Council (H-GAC)

The Houston-Galveston Area Council (H-GAC) is the regional Council of Governments in the Texas Gulf Coast Region, encompassing 13 counties and approximately 12,500 square miles. Included in the region is a population of more than 5,000,000. The City of Houston, in Harris County, is the fourth largest city in the United States and a world center for both port activity and the petrochemical industry.

H-GAC's membership includes 132 member governments, represented on the agency's Board of Directors by publicly elected and appointed officials. H-GAC oversees programs in the areas of Transportation Planning and Analysis, Air Quality Management, Environmental Planning, Community Planning, Economic and Demographic Forecasting and Estimation, Cooperative Purchasing, Criminal Justice Training, 911 Implementation, Health Services Planning, Workforce Development, Services to the Elderly and Handicapped, Geographic Information Systems and Technology Assistance. H-GAC's Transportation Planning Department is also the Metropolitan Planning Organization (MPO) for the region.

Geographic Data Committee (GDC)

In 1995, H-GAC's Data Services Department established a regional Geographic Data Committee (GDC), whose purpose is the exchange of information and technology among its members, and the reduction of data maintenance and development costs. The original

committee of five public agencies has since grown to include 44 member organizations that meet every month. GDC Member organizations include:

Public Agency Members

- City of Houston Planning & Development
- City of Houston Public Works and Engineering
- Port Authority of Houston
- Harris County Justice Information Management System
- Harris County Information Technology Center
- Harris County Flood Control District
- Houston Emergency Center
- Greater Harris County 911
- Houston Metropolitan Transit Authority
- Texas Department of Transportation, District 11
- Texas Water Development Board
- Harris County Appraisal District
- Houston TranStar
- City of Alvin
- City of Baytown
- City of La Porte
- City of League City
- City of Pearland
- City of Pasadena
- City of Texas City
- City of Sugar Land
- City of West University Place
- Galveston Central Appraisal District
- Harris County Engineer's Office
- Brazoria County Engineer's Office
- Fort Bend County Engineer's Office
- Montgomery County 911

Non-Profit Members

- Rice University
- Texas Southern University
- Greater Fort Bend Economic Development District
- Katy Area Economic Development Council
- Houston Community College District
- Waller County Development Partnership

Private Sector, Sustaining (Non-Voting) Members

- Andrew Lonnie Sikes, Inc.
- Alterra Technologies
- KeyMaps, Inc.
- Michael Baker, Jr. Engineering
- R7 Solutions
- LJA Engineering, Inc.
- PBS& J Corporation
- Magellan K12
- Lockwood, Andrews, & Newnam, Inc.
- Claunch & Miller, Inc.
- Civil Tech Engineering, Inc.

BACKGROUND

Joint Development of a Regional Basemap

In its 10 year history, foremost among the Geographic Data Committee's achievements is the creation of a regional base map, adopted as the de facto standard by most public entities within the greater Houston metropolitan area. The U.S. trademarked map, called *STAR*Map*™ (Southeast Texas Addressing and Referencing Map), includes all street centerlines, street names, block address ranges, parcel address points and a thorough set of naming and addressing standards/conventions, for a multi-county area. *STAR*Map*

was created through the cooperative efforts of several public agencies that contributed thousands of hours of technical staff time to collectively capturing, verifying and digitizing data.

Cooperative Map Maintenance

Through annual, voluntary GDC member fee commitments, *STAR*Map* has been continually maintained by a full time, dedicated staff person for seven years, and is distributed to its subscribers, on a quarterly basis. In 2004, more than 85,000 edits were made to *STAR*Map*, including additions, corrections and deletions of street and address data. Edit information comes from member organizations who submit individual or batch edit requests to H-GAC's *STAR*Map* technician. For its work, H-GAC and the GDC received the Environmental System Research Institute's *International Special Achievements In GIS Award*, in 2001.

Cooperatively Purchased Data

Through H-GAC's Data Services Department, the Geographic Data Committee routinely engages in the cooperative specification and purchase of remote sensing data, primarily aerial orthoimagery. In 1997, 1999, 2002 and 2004, the committee contracted for high resolution, orthorectified imagery for thousands of square miles, covering more than eight counties. All imagery acquired by the GDC is placed in the public domain. The committee also contracts for group licensing of various commercial data sets, some of which may be enhanced by licensed users.

*STAR*Map*, aerial imagery and other map data are accessible through H-GAC's ArcIMS site, at http://gdc.h-gac.com.

DATA SYNCHRONIZATION PROJECT

Project Impetus

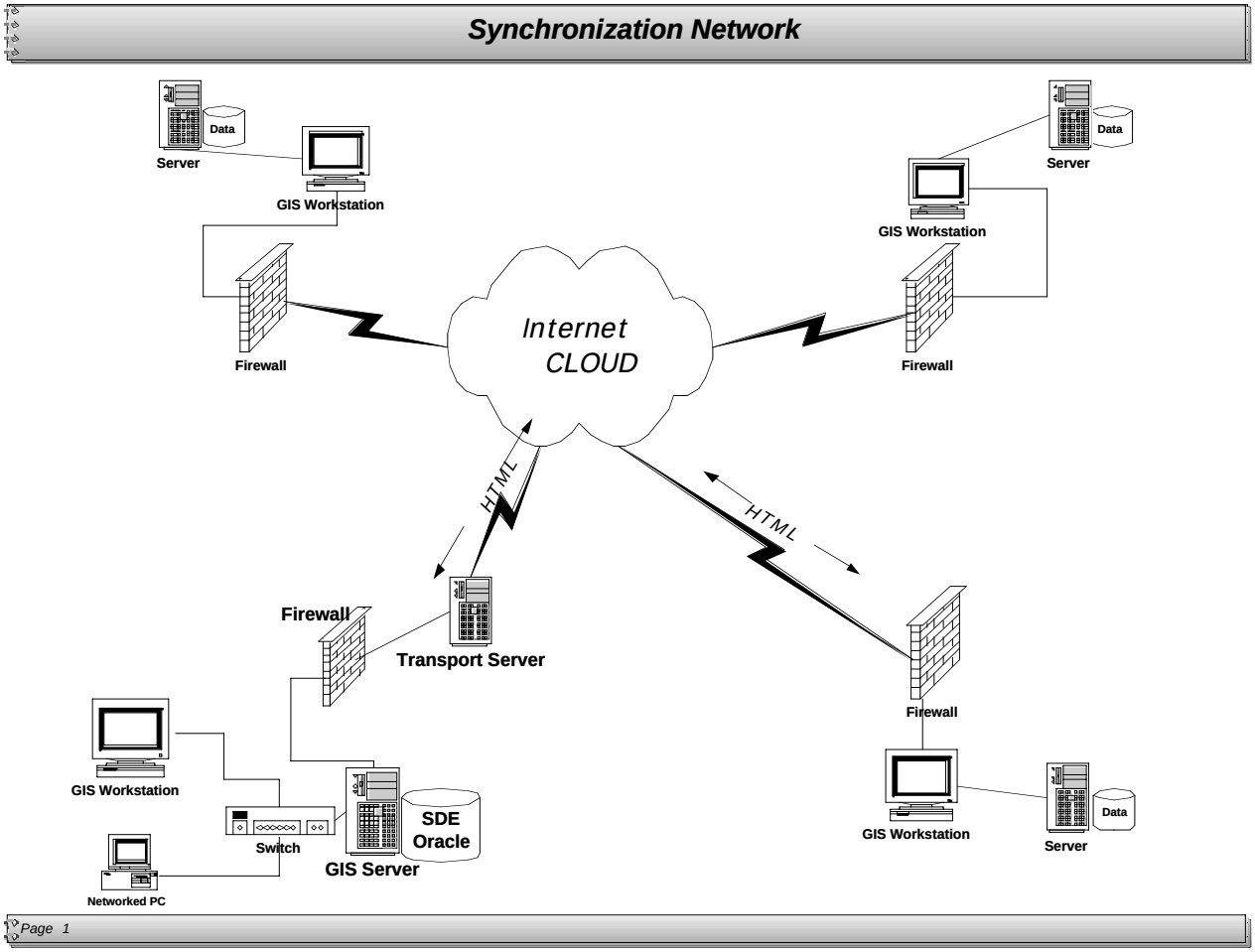
Aside from the customary uses of a street centerline base map, the GDC designed *STAR*Map* with the vision that it would serve as the vehicle for seamless geographic data exchange among user organizations. As a common geographic reference, *STAR*Map* enabled its users to create maps that were compatible across organizations. Unfortunately, even with much of the region's map data developed "on top of" the *STAR*Map* base, organizations have found it too cumbersome to continually deliver updates of their own data to each other. As both a security issue and a practical matter, there was a compelling need for the ability to replicate and share data across a ubiquitous network.

Data built around a common base lends itself to hosting in a comprehensive repository. The idea of creating a central repository as a clearinghouse for the region's data was reviewed by the GDC and held some real potential, at first. The idea was that an enormous, regional compendium would enable users to seamlessly access and overlay features culled from a host of sources. But the idea presented significant technical and political challenges. Coupled with the prohibitively high, ongoing cost of secure, leased

broadband, the idea of seamless, region-wide data transportability remained only a theoretical possibility, until now.

Project Overview

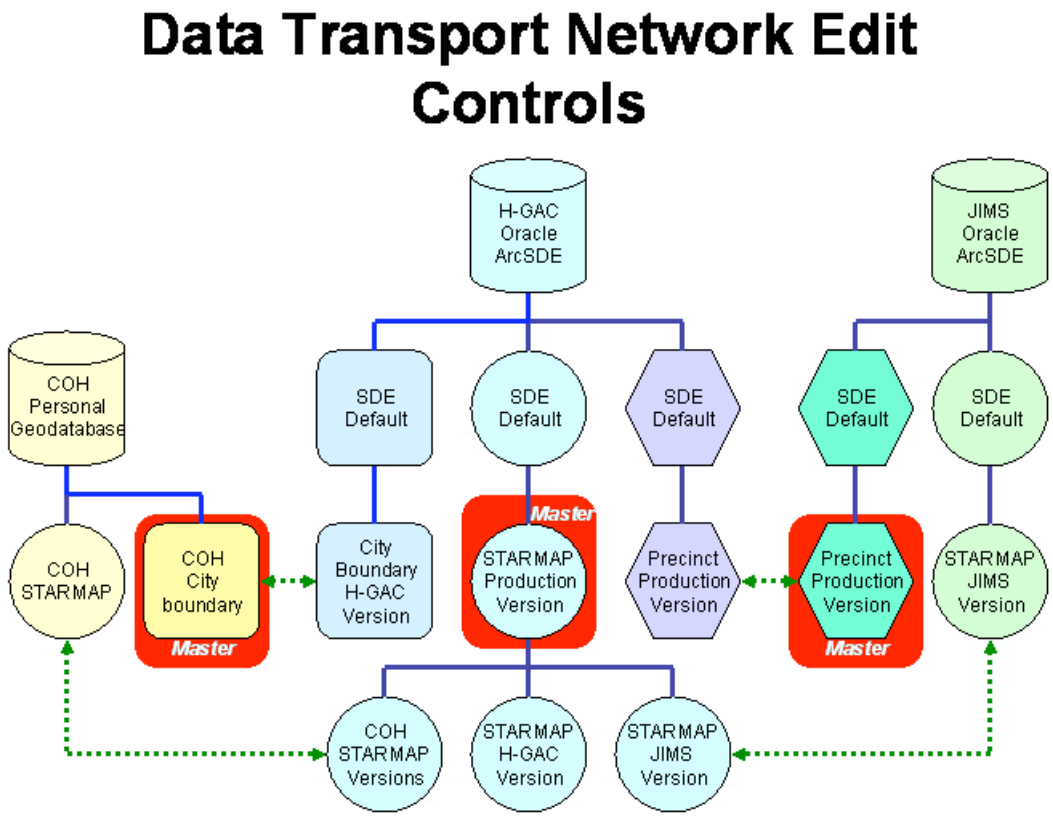
In late 2004, H-GAC purchased a software product called *GO! Sync*, from the firm *Tadpole Technology. GO! Sync* enables multiple remote sites to synchronize geodatabases with each other, via the Internet, using very narrow bandwidths. Although the product historically focused on applications within the utilities industry, H-GAC and Tadpole Cartesia successfully piloted a project to replicate map and attribute data among three different organizations with disparate GIS data sets. Conceptually, the idea is fairly straightforward; once a site's data set is copied to a remote location, future edits can be appended at the replicated site, updating the existing version. The edit data is transported in XML, requiring only a small bandwidth and can be made either in real time, or through scheduled batch processing. The *GO! Sync* product, itself, manages data routing and security through use of a *Transport Server*, which acts as a router, caching and queuing device.



Generalized diagram of data transport network structure

The pilot project involved data replication, transport and synchronization among three organizations: the Houston-Galveston Area Council (H-GAC), Harris County Justice Information Management System (JIMS) and the Harris County Public Infrastructure Engineering Division (HCPID). H-GAC purchased and configured a transport server, then installed a *GO! Sync* client license at each agency's site. Participants then added a Global User ID (GUID) to their own, internally produced data sets and installed duplicate copies of the data at the other entities' sites. At that point, it was possible to begin transporting XML-based edits via the Internet, through the GO! Sync transport server, and capture them to a central Oracle/SDE database.

The initial testing of the GO! Sync product demonstrated that it met GDC requirements for enabling the concurrent maintenance of spatial datasets from geographically dispersed sites. As new organizations and their data are added to the Transport Network, the system will require that they adopt the use of GUIDs, which will entail a significant amount of advance planning work. The use of GUIDs is discussed more fully in the portion of this paper, *GO! Sync Installation, Setup and Configuration*.



The *Transport Network Edit Controls* diagram, above, illustrates that each participating entity can "own" a master copy of their data (highlighted in red). H-GAC, for example, owns the master of *STAR*Map.* Via the Transport Network, *STAR*Map* is available to other organizations that each have the ability to perform edits on their own copy, or "version." Their changes can then be saved as edit versions of the master copy and

replicated back to H-GAC, where changes are reviewed by an administrator and, if approved, saved back into the master.

In the same way, each of the other organizations own master copies of data *they* are responsible for. They, too, can make versions available to other organizations for viewing and editing, review the edits replicated back to their own site and determine whether those edits will be committed to the master, or simply kept separate as the other organization's working copy.

Edits can be transported, either in real time, or as scheduled batch releases. A variation of the model would have all masters managed at one site, with approved edits saved to the master copy by a central administrator. Each "owner" site would work from a versioned copy. (Tadpole Cartesia also offers "View-Only" licenses for organizations wishing to access data, without performing actual edits/updates.)

NEAR-TERM PROJECT SCOPE

The goal of the project is to expand the initial pilot, linking and replicating data among nine primary public agencies within the greater Houston metropolitan area. The front-line organizations for the expanded project include: Harris County Flood Control District; Harris County Appraisal District; Texas Department of Transportation District 11; City of Houston; Greater Harris County 911; and Fort Bend County Engineer. Expansion of the data network will endow its participants with the following resources:

1. ***Data Availability and Security*** – Critical data sets, such as utility locations, flood zones, emergency evacuation routes and other information would be replicated at many different sites, at all times. Data lost from a host site, whether the result of system failure, natural disaster, or terrorism, would be available in its most current form from any of the replicating sites.

2. ***Real-time Access to Sensitive and Critical Data*** – For agencies to be able to make accurate use of each other's data, it is crucial that they have the most current available. Real-time, or batch-processed daily data transport would ease the burden on many agencies that must coordinate capital improvement projects, or provide emergency response *and* recovery services.

   Some data simply do not age as well as others. City of Houston permit data, for example, is often substantially delayed in being ported into emergency services' databases. Parcels may be subdivided and permitted by the City for additional residential, or commercial construction, without showing up in 911 dispatching data for several weeks, because the changes must first be manually transcribed at the county appraisal district. The appraisal district's data must then be copied to 911.

3. ***Improved Data Quality*** – It is well documented and equally well understood by GDC member agencies, that shared data access results in substantial, meaningful improvements to data quality. Increased data use by other organizations, either internally, or in the field, invariably results in the identification and correction of data errors that might otherwise go unnoticed, until discovered during an emergency.

COORDINATION WITH STATE AND FEDERAL AGENCIES

State Coordination

Many of the attributes of *STAR*Map* have been adopted by the State of Texas, for incorporation into its statewide *StratMap* project, conducted by the Texas Natural Resources Information System (TNRIS) and the Texas Water Development Board. The Texas Water Development Board is a voting member of the H-GAC Geographic Data Committee and a partner in many GDC projects.

H-GAC and the Geographic Data Committee provide *STAR*Map* updates to the Texas Water Development Board (TWDB), for use in the statewide Strategic Mapping Program (StratMap). Through H-GAC and the GDC, local agencies coordinate with the TWDB and the State of Texas to ensure that maintained features and data are compatible with state and federal guidelines. The Texas Water Development Board, through its Strategic Mapping Program, has used H-GAC's *STAR*Map* data in developing framework data. TWDB maintains statewide transportation and political boundary framework layers and collects data from local, regional, state, and federal agencies. These different datasets are combined to create a seamless statewide coverage.

At the time of this writing, initial efforts are underway to coordinate some of the Houston region's transport network database design elements with state agencies. If the regional effort is successful, a longer-term goal is to expand the network to tie in with TNRIS, TWDB and the Texas Department of Transportation.

Federal Coordination

H-GAC's Internet Map Server (IMS) website is a Federal Geographic Data Committee (FGDC)-compliant metadata catalog. Called a "Clearinghouse Node," H-GAC's site is in the FGDC Registry (http://registry.fgdc.gov/viewrecord.php?rec=521) and is a metadata resource within the Geospatial One-Stop (GOS) Portal. (The H-GAC ArcIMS server has been registered as a GOS Portal operational Z39.50 Clearinghouse Node.) Also, the Web Mapping Service (WMS) connector for ArcIMS runs on the H-GAC ArcIMS server. This WMS connector is OGC Web Mapping Service Version 1.1.1 compliant.

Currently IMS website data include street centerlines with street names, block address ranges, parcel address points, hydrology, census data, environmental and forecast data, political boundaries, zip codes, and other jurisdictional information. Users also have access to some private sector data, such as business locations by type, locations of career

centers and educational facilities. The proposed project will dramatically expand available data, by centrally distributing other, separately maintained feature sets, such as flood zone boundaries, rights of way, emergency service boundaries, crime statistics, land use, public works data, transportation facility details and capital improvement projects.

H-GAC's GIS ENVIRONMENT

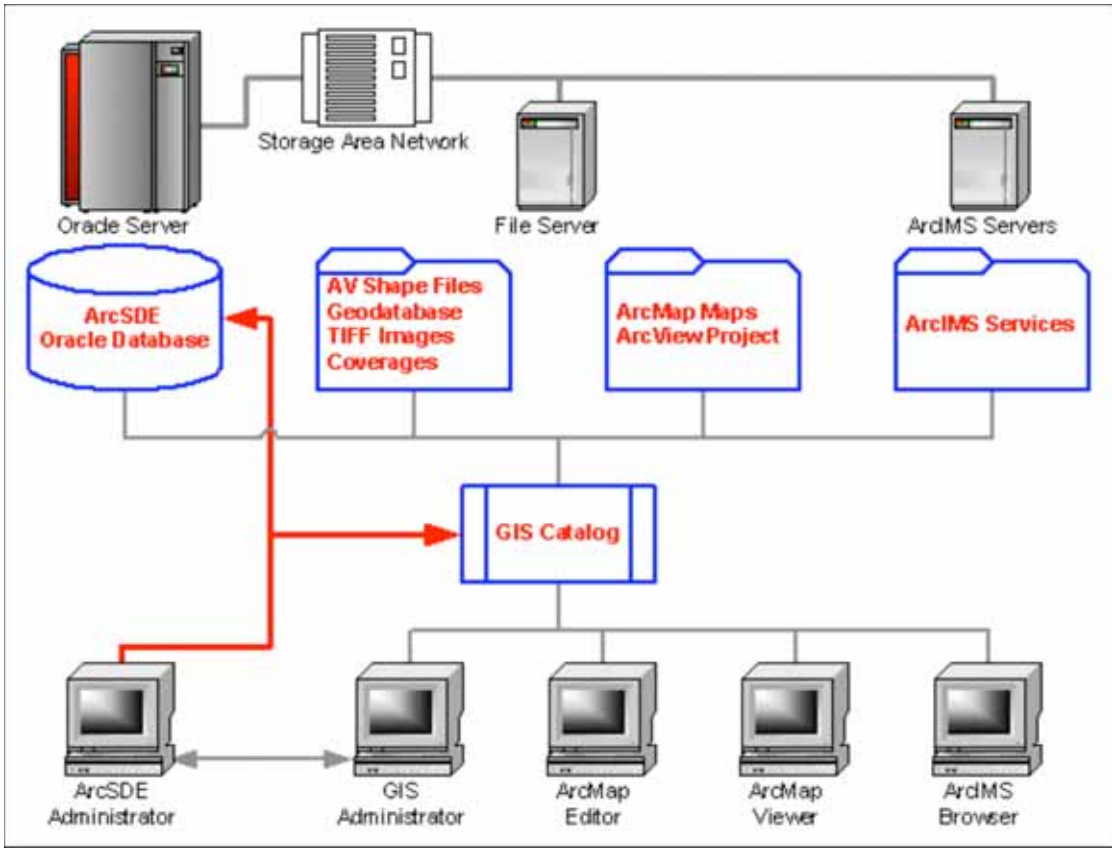
The Houston-Galveston Area Council has been an ESRI GIS site, since 1991. Currently, centralized data is managed in an Oracle 9i environment and used by ArcGIS 9.x, via ESRI's Spatial Data Engine (SDE). Data is stored on a multi-terabyte Hewlett Packard VA Series Storage Area Network (SAN). Data is served to the Internet, via three Arc IMS Servers, v4.01. The three servers are variously dedicated to Transportation, Environmental and broad public use data, as well as hosting limited access data for certain public agency partners.

At present, there is more than one terabyte of data available via the IMS server system. The data serves several groups, including internal H-GAC users, member organizations (some of whom have secure access accounts for use of licensed commercial data) and the general public. Public users are principally from within the Houston-Galveston Area Council's 13 county planning region, although a significant number are from other cities within the State of Texas, as well as outside the state.

H-GAC's IMS SERVICE

H-GAC's Data Services Department's GIS data repository framework includes:

- ArcSDE Oracle database,
- Non-ArcSDE GIS layers,
- ArcMap maps and ArcView projects,
- ArcIMS services, and
- ArcIMS Metadata catalog.



Descriptions of these components are presented in the following sections.

ArcSDE Oracle Database

The first component is an ArcSDE Oracle database. Two major benefits of having ArcSDE are:

- An ArcSDE feature class can be accessed and also edited by more than one person at a time.
- ArcMap handles large ArcSDE feature classes (such as *STAR*Map* which has more than 300,000 road segments) better than the same layers in a personal geodatabase.

Both ArcSDE GIS feature classes and related attribute tables (such as Census 2000 population) are available on the Oracle database. The following datasets were put into the database in May, 2003: STAR*Map, Tiger2000, Census 2000, American Business Information employer datasets, 1 meter aerial orthoimagery for Harris, Fort Bend, Brazoria, Galveston, Chambers, Liberty, Montgomery and Waller counties. The following datasets are scheduled for near term inclusion in the database: Tiger 90, Census 90, rural county 911 base maps, City of Houston's COHGIS data, Houston Metropolitan Transit Routes, Harris County Sheriff's Precinct boundaries, Harris County parks, Harris County Flood Zone boundaries and Harris County Appraisal District parcel boundaries.

Non-ArcSDE GIS layers

This component includes ESRI shape files, ESRI personal geodatabases, TIFF/SID images, and attribute data in DBF, MS Access, or MS Excel format. All datasets will be stored in a network folder. Although a dataset can be accessed by more than one person at a time, only one person can edit the dataset at a time. To prevent corruption of the datasets, this network folder will be read-only to most users. GIS administrators in each department will have read/write access rights to the folder.

ArcMap Maps

This component includes ArcMap maps and ArcView projects in a read-only network folder. A map in this folder will only use GIS layers (ArcSDE or non-ArcSDE) in the GIS data warehouse, simplifying maintenance of this component, while allowing non-GIS users to access maps by simply double-clicking a selected map file.

Web-based services

ArcIMS map services are available for internet and intranet. A map service will only use GIS layers in the GIS data warehouse. Users inside or outside H-GAC will be able to access certain maps via their web browsers. The ESRI ArcIMS server is OGC, WMS and WFS compliant.

ArcIMS Metadata Server (GIS catalog)

ArcIMS Metadata Server (or, GIS catalog) is essential for the agency-wide GIS data warehouse to work. The GIS catalog will have a list of all available GIS layers and attribute datasets in the data warehouse, along with a web-based interface with search capabilities. H-GAC uses ESRI ArcIMS Metadata server to host its GIS catalog. The metadata server is also equipped with a Z39.50 connector.

PART II

GO! SYNC INSTALLATION, SETUP AND CONFIGURATION

Contributed by Grant Garrison, H-GAC GIS Program Manager

BASIC COMPONENTS

Server *(GO! Sync Server – Transport Server)*

- Purpose is to manage the communication of each of the remote client site's Geodatabases (Personal or Enterprise Geodatabase) and the central site's Enterprise Geodatabase (Central Repository).
- Acts as a GIS data router that caches and queues edits made by each client site to the central repository site and vice versa.
- Functions very similarly to a Web Server. Must be fully accessible to the Internet, requiring it to be outside the central site's (hosting organization) Firewall.
- Basically just passes XML files back and forth between the central site (host) and each of the remote client sites. It also ensures that the communication of the files is secured through encryption and that only registered remote sites are able to send and receive the XML files.

Client *(GO! Sync Client – ArcGIS Extension & Messaging Service)*

- ArcGIS Extension (ArcCatalog and ArcMap components)
- ArcCatalog Component: Used to initially setup and manage the local Geodatabase configuration for synchronization thru GO! Sync.
- ArcMap Component: Edits are made to the local Geodatabase and where other client's edits may be viewed in the local Geodatabase using ArcGIS ArcMap. Edits to the clients local Geodatabase are simply made using standard ArcMap editing tools. No other editing tools are required; just those right out of the box that come with ArcMap. When edits are saved, the GO! Sync extension wraps up those edits/changes into an XML file and can then send that XML file live/real-time to the central site for inclusion in the Central Repository. Once accepted by the GO! Sync Administrator at the Central Site Repository (central Enterprise Geodatabase), edits are reconciled and posted and sent to each of the other remote client sites, automatically.
- Messaging Service: Ensures that the client can communicate with the Server. If communication is offline, the service lets the client know that it cannot communicate with the Server. The service is always running on the client desktop regardless of whether ArcGIS is running or not. It

simply ensures that communication is functioning properly between the client and the Server.

SERVER SYSTEM REQUIREMENTS

Basic/Minimum System Requirements

- RAM: 256 MB
- CPU: Pentium PIII (800 MHz)
- Storage: 1 GB
- Swap Space/Virtual Memory: 512 MB
- OS: Windows NT 4.0 (Service Pack 6) or Windows 2000 (Service Pack 2)
- Web Browser: MS Internet Explorer (5.5 or newer with 128-bit encryption)
- Application Support: Java Runtime Environment (JDK – Version 1.3)
- Database: MySQL Database (Version 3.23.49)
- Network: Network Card (MAC Address) with Static IP Address
- Default Ports: 443, 7443, 7444, 8083, 9080, 9443

Recommended/Preferred System Requirements

- RAM: 512 MB or more (the more the merrier)
- CPU: Dual Pentium 4 (the faster the better)
- Storage: 2 GB (RAID Level 5 – full redundancy)
- Swap Space/Virtual Memory: 1 GB
- OS: Windows 2000 Server

CLIENT SYSTEM REQUIREMENTS

Basic/Minimum System Requirements

- RAM: 512 MB
- CPU: Pentium PIII (800 MHz)
- Storage: 1 GB (NTFS or FAT32)
- Swap Space/Virtual Memory: 300 MB
- Video Card: 32 MB VRAM and supports greater than 256 color depth
- OS: Windows 2000 Pro (Service Pack 2) or Windows XP Pro
- Web Browser: MS Internet Explorer (6.0 or newer with 128-bit encryption)
- Network: Network Card and TCP/IP (DHCP is OK)

Recommended/Preferred System Requirements

- RAM: 1 GB (the more the merrier)
- CPU: Pentium P4 or Xeon (2 GHz - the faster the better)
- Storage: 2 GB (NTFS)

- Swap Space/Virtual Memory: 300 MB
- Video Card: 64 MB VRAM and OpenGL 1.1 or above
- OS: Windows 2000 Pro (Service Pack 2) or Windows XP Pro
- Web Browser: MS Internet Explorer (6.0 or newer with 128-bit encryption)
- Network: Network Card and TCP/IP (DHCP is OK)

SERVER INSTALLATION AND CONFIGURATION

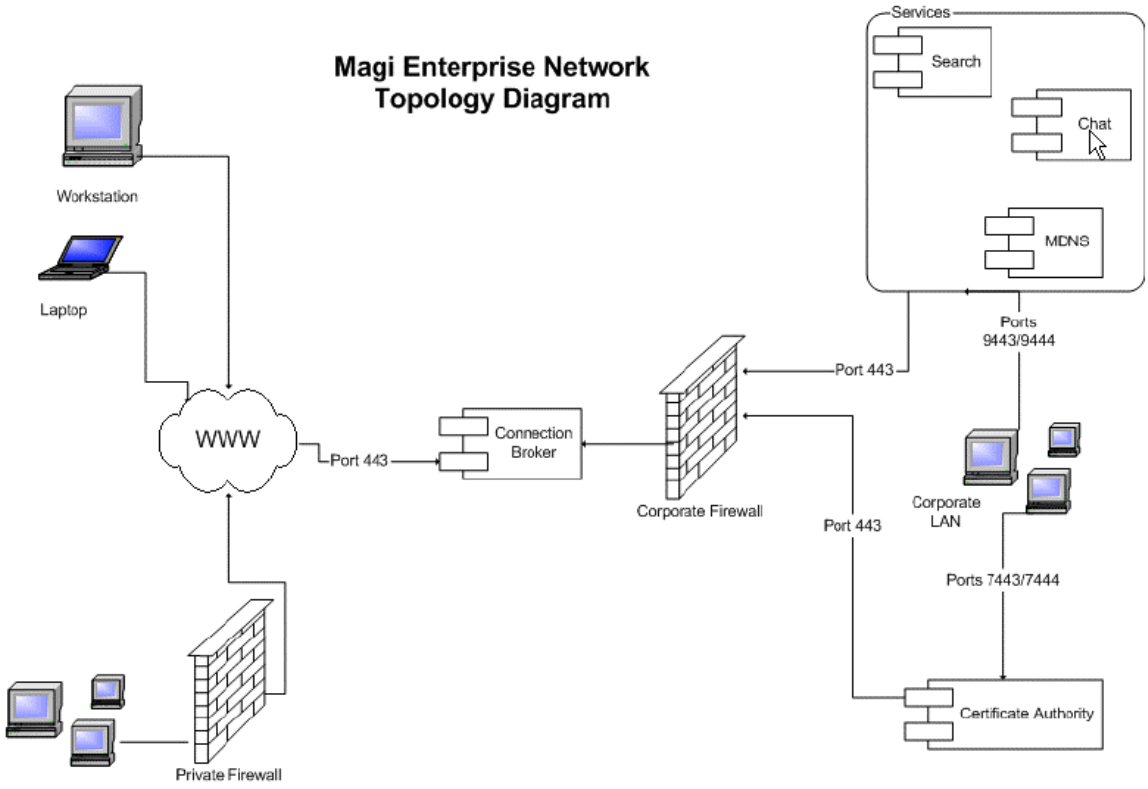
Pre-Installation Requirements

- Acquire license keys from Tadpole Cartesia for Server Components
    - Run a utility called MagiLicense.exe that analyzes the MAC Address and IP address of the Server and creates a file that must be sent to Tadpole via email
    - Tadpole sends several files back to end user via email
        - CA'Services.cer
        - CA'Services.p12
        - CA'Services.pem
        - License.key
        - License.pol
        - MDNS'Services.cer
        - MDNS'Services.p12
    - The license keys enable the setup and configuration of the Server and are required before installing GO! Sync Server software.

Server Components Defined

- Magi Connection Broker (CB)
    - Allows users to collaborate with one another seamlessly across corporate firewalls while adhering to security policies established by their IT departments
    - Requires Port 443 to run
- Magi Services (MDNS)
    - Maintains presence for the GO! Sync clients.
    - Presence determines the IP address of each GO! Sync client and whether they are currently running or not.
    - Updates presence database stored on Server (MySQL database) when clients change IP addresses.
    - Allows clients to change IP addresses and still maintain security.
    - Maps IP addresses to buddy names.
- Magi Certificate Authority (CA)
    - Serves out digital x.509 certificates binding a particular user to a device.
    - Certificates contain public and private keys used for encrypting and decrypting, are installed on a particular device, and cannot be transferred between devices.

- Magi Search
    - Supports partitioning of the search space on a dynamic, up-to-the-minute basis
    - Accomplished through "pushing" metadata to a repository on local document changes in addition to traditional crawling and indexing techniques.
    - If a device is offline, it can retrieve a copy of it from its cache.
    - Caching enables limited bandwidth devices to redirect resource requests to its cache.



Installation and Configuration Steps

1. Install Magi Enterprise Connection Broker Application
    a. Install CD – EnterpriseCB.exe
    b. After installation is complete the Connection Broker will run as a Windows Service.
    c. Can check to make sure Connection Broker Service is running by checking the Windows Services and also by putting the Server IP Address and Connection Broker Port # in the address bar of web browser (http://GO! Sync Server IP Address:443)
2. Install Magi Certificate Authority Application
    d. Install CD – EnterpriseCA.exe

    e. Install Magi Services
        i. Install CD – EnterpriseServices.exe
    f. Install the Database
        ii. Must install MySQL on Server in order for Magi Service to run
        iii. If MySQL not installed there is a copy of it on Install CD just run setup.exe from the my-sql.zip file.
3. Configure the Database
    a. Start the MySQL Admin GUI Tool by running winMySQLadmin.exe
    b. Set variables for the database in the myini.insert file using a text editor
    c. Run sql scripts provided by Tadpole to configure MySQL database for Magi Services.
4. Registering Magi Services
    a. After installing and configuring the MySQL database must register the components that make up Magi Services.
    b. Install CD – WinMagi.exe
    c. Enter Username and Password for Certificate Authority (security)
    d. Enter CA'Services.p12 file that Tadpole emailed to user
    e. Enter Server IP Address and Port # (443)
    f. Directory Service Information
        i. Enter Server IP Address and Port # (443)
        ii. Enter MDNS'Services.p12 that Tadpole emailed to user
        iii. Enter Username and Password for MDNS Servies
    g. Database Configuration
        i. Enter Server IP Address
        ii. Enter Username and Password for MySQL Database
        iii. Enter Path where MySQL log file stored on Server
    h. Confirm that Magi Services are running properly
        i. At browser enter Server IP address and port # (7743) and path to Magi Certificate Authority folder
            - Example: https://205.55.248.99:7743/Magi/CAServer
5. Configure Certificate Authority
    a. Install CD – WinMagi.exe
    b. Enter Server IP address and Connection Broker Port # (443)
    c. Enter the path where CA'Services.cer file is stored that was emailed to user by Tadpole
    d. Enter the path where MDNS'Services.cer file is stored that was emailed to user by Tadpole
6. Configure Search Information
    a. Install CD – WinMagi.exe
    b. Enter Server IP address and Connection Broker Port # (443)
    c. Enter the path where MDNS'Services.cer file is stored that was emailed to user by Tadpole

Server Installation and Configuration Complete

CLIENT INSTALLATION AND CONFIGURATION

Pre-Installation Requirements

- Must have ArcGIS 8.3 or 9.0 (Service Pack 2) installed and running properly on client desktop computer
- Client desktop computer must have Internet access
- Must have Admin rights/privileges to install software on client desktop computer
- End user on client desktop computer must have Power User privileges

Installation and Configuration Steps

1. Install and Configure GO! Sync Transport Client (TC) from Install Disk
    a. Three Steps – Installation, Registration, and Configuration
    b. Run GO! SyncTransport.exe from install disk
    c. Select either Edit or View license
    d. Choose installation folder for application
    e. Register Client with GO! Sync Server (Magi)
        i. Enter Server IP address and Connection Broker Port # (443)
        ii. Enter the path where CA'Services.cer file is stored that was emailed to user by Tadpole when originally setting up Server
        iii. Enter the path where MDNS'Services.cer file is stored that was emailed to user by Tadpole when originally setting up Server
    f. Setup Client as a buddy to the GO! Sync Server (Magi)
        i. Enter Username (defined when setting up Server)
        ii. Enter Password (defined when setting up Server)
        iii. Enter Authorization Code (provided by Tadpole)
        iv. Choose Buddy Name (Individual client name)
            - Used to identify each individual client in the GO! Sync system
            - Comprised of 2 parts – a username and a device name
            - Must be unique for each client
    g. Setup Locator/Search
        i. Enter Server IP address and Connection Broker Port # (443)
    h. Final Configuration
        i. From Magi Enterprises application must Register Buddy with GO! Sync Server
        ii. Client must Contact GO! Sync Server Administrator and inform them of their buddy name and ask them to confirm registration

iii. Once Registration of Buddy is confirmed then GO! Sync Transport Client (TC) is complete

2. Install GO! Sync Edit from Install Disk
    a. Run GO! SyncEdit.exe from install disk
    b. Confirm that ALL users may use this application

3. Install GO! Sync Edit Geodatabase Extension from Install Disk
    a. Must be installed on all clients that intend to edit the Geodatabase
    b. Purpose of this application is to maintain a GO! Sync globally unique identifier (a global OID – gOID)
    c. Run GO! SyncEditObjects.exe from install disk
    d. Once installed the Geodatabase extension operates automatically, it requires no intervention from the user

4. Configure GO! Sync Edit
    a. Configuration information for both GO! Sync Edit client and the GO! Sync Server is stored within system tables within the Central Enterprise Geodatabase Server.
    b. Configuration of these components on both the client and server must be completed while connected to the Central Enterprise Geodatabase (host)
    c. Upon completion, remote client configurations can be exported into configuration files in XML format from the host.
    d. Remote clients simply loads the configuration files to become synchronization partners with the GO! Sync Server and Enterprise Geodatabase (host)
    e. GO! Sync Edit system tables must exist before importing an XML configuration into a remote client Geodatabase.
    f. Very important point – the Geodatabases on both the GO! Sync Server Enterprise Geodatabase (host) and each of its remote client's are at the exact same state when the synchronization is initiated for the first time
    g. On GO! Sync Server (host) must create a GO! Sync database user account on the Central Enterprise Geodatabase Server (hosting organization)
        i. Requires at least 50 MB of space to hold the GO! Sync system tables for all the remote clients and the host
        ii. The GO! Sync database user account should have SELECT privileges on all the data objects (all Geodatabase Feature Classes and tables) that will participate in the synchronization process
        iii. Required Oracle Privileges
            - CREATE SESSION
            - CREATE TABLE
            - CREATE PROCEDURE

- CREATE SEQUENCE
- CREATE TRIGGER
- UNLIMITED TABLESPACE

iv. When loading objects in Enterprise Geodatabase ensure that object names are in upper-case letters. A GO! Sync requirement.

v. Recommended that an object is not registered as versioned. Non-versioned objects result in a faster GUID population process. Should register as versioned when making them compliant with GO! Sync Edit client in a later step but not initially when first setting up.

vi. Must populate each Geodatabase layer that is to participate in the synchronization process with a GUID. The GUID's between the Central Server Enterprise Geodatabase and each of the client's Geodatabases must match one another

vii. GO! Sync Server Enterprise Geodatabase Administrator must create a spatial database connection in ArcCatalog and connect as the gosync user.

viii. GO! Sync Server Enterprise Geodatabase Administrator should open the GO! Sync Edit toolbar in ArcCatalog

ix. GO! Sync Server Enterprise Geodatabase Administrator must connect to the Central Enterprise Geodatabase as the gosync user in ArcCatalog to create the System Tables.

x. Click the create GO! Sync Edit system tables in ArcCatalog for the Enterprise Geodatabase objects that will participate in the synchronization process

xi. After successfully completing the system tables on the Enterprise Geodatabase those system tables must be populated by the Administrator with the configuration for each of the clients and the Server for each Central Enterprise Geodatabase Version
    - Open the Configuration Tool (TC) from the GO! Sync Edit toolbar in ArcCatalog
    - Configuration Local Settings tab – used to define GO! Sync Server general configuration information
    - Remote Site Settings tab – used to configure the remote clients and their relationship with the central server
    - Export Triggers (Modes) tab – used to configure the exporting modes (batch, real-time/live, etc.) of the Central Server with each of the remote clients
    - Complete (Fill In) the Local Configuration tab
        - ✓ Site Name – contains the GO! Sync Client buddy name for the GO! Sync Enterprise Geodatabase Server Administrator (host)
        - ✓ Application Name – contains the GO! Sync Edit application name. The combination of the Site

Name and the App Name is used to construct a unique GO! Sync Central Enterprise Geodatabase Server instance when multiple instances are on the same Server

- ✓ Region Layer – used to define a geographical region in the Geodatabase layer for a synchronization dataset
- ✓ Region Column – column in the region layer table that contains the index of the spatial region
- ✓ Import Mode – Mode for importing/loading synchronized changes into the Geodatabase
    - ➢ Auto-Import (Both) – whenever GO! Sync Edit starts up or is closed down it checks the queue and loads all change files that might be waiting. When a change is received, it will also load it automatically. This is the most fully automated import mode.
    - ➢ Auto-Import (File Received) – GO! Sync Edit loads a change file whenever it arrives and the Central Enterprise Geodatabase server is not in the edit session
    - ➢ Auto-Import (Start Up) – whenever GO! Sync Edit comes online it receives events and adds the incoming change files to a queue and loads change files from the queue.
    - ➢ Manual-Load (Both) – loads all change files to and from the change file queue by manually selecting button
    - ➢ Manual-Load (File) – manually load individual change files. This option is aimed at the administrator to provide greater control over the load process and also allows for manual loading of missing change file, if experienced (work around in case something fails – a back door solution for loading change files).
    - ➢ Manual-Load (Queue) – manually trigger the loading process for change files. This option gives the gosync user (Central Geodatabase Administrator) an option to decide when to load the change files stored in the queue. When the Administrator clicks the load button all files queued in the change file queue will be loaded into the

system, if there is no active editing session in progress.

- Select the Geodatabase datasets that will be synchronized for this configuration
- After completing the Local Configuration tab the configuration information is stored within the system tables inside the Central Enterprise Geodatabase (host).
- Complete (Fill In) the Remote Sites tab
  - ✓ Name – a valid GO! Sync client buddy name of the remote client computer that will be participating in the synchronization process.
  - ✓ Application Name - contains the GO! Sync Edit application name. The combination of the Name and the Application Name is used to construct a unique GO! Sync Central Enterprise Geodatabase Server instance when multiple instances are on the same Server
  - ✓ Shared Version – a valid Geodatabase version name in the GO! Sync Enterprise Geodatabase (host Geodatabase). Must be a fully qualified name in uppercase letters. To be accessible by the Configuration Tool, the version must be created prior to running the tool. The access property for this version needs to be at least set to 'protected'.
  - ✓ Region of Interest – provides the ability to select which regions this remote client should be synchronized on.
  - ✓ Remote Version – this should contain the version on the remote client that the change packet should be imported and exported from. If the remote client is an Enterprise Geodatabase version, then the shared version name on the remote client is used to map to the shared version on the Central Enterprise Geodatabase Server. Note, Enterprise version names must be fully qualified in uppercase lettering If the remote client is simply using a Personal Geodatabase then PGDB should be selected for Remote Version. The synchronization occurs between the remote client (Personal Geodatabase or Enterprise Geodatabase version) and the Central Enterprise Geodatabase Server (host).
  - ✓ Import Mode – same as local configuration tab
  - ✓ Export Mode – three types available
    - ➢ Auto Export (Stop Editing) – whenever the user ends an edit session in ArcMap, it

automatically creates a change file and sends it out to its remote clients
- Manual Export – end user manually initializes individual change files creation/transmission by clicking the button
- Auto Export (Periodic) – this is a time option that allows the client to set time intervals for each change file creation/transmission.

- Complete Export Triggers (Modes) Tab
  - ✓ Version Name – the version name on the Central Enterprise Geodatabase (host) that corresponds to the remote client
  - ✓ Export Mode – same as above

- After all Configuration Tool information has been completed for both the remote clients and the Central Enterprise Geodatabase then that configuration information must be exported out to an XML file by the GO! Sync Server Administrator and sent to the individual remote client.
  - This is accomplished by clicking the Export GO! Sync Configuration to XML button found in the GO! Sync Edit toolbar in ArcCatalog.
  - Must select the correct remote client buddy name that the configuration file will be distributed to and a location to save the XML file to and later distributed to the remote client
- Once the remote client receives the XML configuration file they must import it into their own Geodatabase.
  - The remote client's Geodatabase must contain all the necessary data that is held in the Central Enterprise Geodatabase Server (host) before beginning synchronization.
  - If this hasn't been done already then the GO! Sync Administrator must export the Geodatabase layers that are to be synchronized out of the Central Enterprise Geodatabase into a Personal Geodatabase and distributed to the remote clients to use
  - The remote client must first create system tables on their local Geodatabase.
  - This is accomplished by clicking the Create GO! Sync System Tables button on the GO! Sync Toolbar in ArcCatalog
  - Once that is completed then the XML configuration file is ready to be imported into the remote client's Geodatabase

        - This is a accomplished by clicking the Import GO! Sync Configuration from XML button on the GO! Sync Toolbar in ArcCatalog
        - Note as stated earlier the remote client's Geodatabase and the Central Enterprise Geodatabase GUID's must match each other exactly. The GUID is used by GO! Sync to reconcile changes between the two Geodatabases (remote client and Central Enterprise Geodatabase). If the two Geodatabases don't have matching GUID's then GO! Sync will get confused and will not able to synchronize the data.
    - GO! Sync client Installation and Configuration Complete

HOW SYNCHRONIZATION WORKS

Pre -Synchronization Requirements

- GO! Sync Server must be up and running (online)
- Client must have a live internet connection
- Client's ArcGIS must be running properly
- Client must be able to connect to their local Geodatabase (Personal or Enterprise Geodatabase) without any problems. If it is an Enterprise Geodatabase, then ArcSDE and RDBMS must be up and running properly.
- Client must be able to turn on the GO! Sync Extension in ArcMap.

Synchronization Steps

- Client must login to desktop computer that has GO! Sync Edit client software installed and configured
- Client must have Power User login privileges on computer with GO! Sync client software
- Client must start ArcMap application
- Client must ensure GO! Sync Server is online by checking Tadpole icon (Transport Client) on system tray. If grayed out then Server is offline and synchronization will not occur until Server is online. The Tadpole icon on the system tray should automatically come up when the client's desktop is booted up.
- Client must connect to the Geodatabase in ArcMap that is to be synchronized using GO! Sync
- Client must turn on GO! Sync Edit toolbar (Extension) within ArcMap and must be in an open Edit Session.
- If import mode (configuration) set to automatic then changes from Central Enterprise Geodatabase Server will be automatically loaded/imported into the client's local Geodatabase. If set to manual import then the client will have to click the manual import button in order for the changes from the Central Enterprise Geodatabase Server to be loaded into the local Geodatabase.

- Client edits to local Geodatabase must be done through ArcMap and in an Edit Session in order for them to be exported and synchronized with GO! Sync.
- There is nothing different about editing a GO! Sync Geodatabase layer than any other Geodatabase layer (non-synchronized). The process of editing a Geodatabase layer in ArcMap is standard. As a reminder, here are the steps for editing Geodatabase layer in ArcMap.
    - Turn Editor toolbar on, if not already on in ArcMap
    - Start an Edit session
    - Select the target Geodatabase layer to be edited
    - Select the proper edit tool for the type of edit that is to be made to the Geodatabase layer
    - Make all the necessary edits to the Geodatabase layer
    - Save the Edits for the Geodatabase layer
    - When complete with all edits to the Geodatabase layer then close the edit session by selecting Stop Editing from the Editor Toolbar.
- Once the edit session is closed and all the edits are saved to the local Geodatabase then those changes maybe automatically exported and synchronized with the GO! Sync Server if the export mode was set to automatic otherwise the client will have to click the button on the GO! Sync Toolbar to manually export and synchronize the changes (export).
    - Essentially what the GO! Sync client software is doing is taking all the changes by the client to the local Geodatabase and wrapping them up into an XML export file and transmitted them over the internet through the GO! Sync Server to the Central Enterprise Geodatabase Server.
    - Once the changes are transmitted from the client to the Central Enterprise Geodatabase Server they must be imported by the Administrator and reconciled and posted to the Geodatabase Parent Version (parent version to all the clients – clients are children versions). Once those edits have been reconciled and posted to the Parent version then they are wrapped up into XML and transmitted to all the other remote clients.
- The synchronization process is dependent on the Geodatabase layer being in an open or closed Edit Session.
- Editing is very simple and does not require any additional effort on the part of the client other than to click the synchronize edits button on the GO! Sync toolbar if it isn't set to automatic. If the mode is set to automatic then the edits are synchronized automatically when the edit session is closed or opened.

THAT'S IT! WASN'T THAT EASY???

H-GAC PROJECT PERSONNEL

Max Samfield, Director,H-GAC Data Services Department
Mr. Samfield directs activities of both the Information Technology group and the central GIS Development and Management group. He is the founder of the Geographic Data Committee and has orchestrated cooperative agreements, such as the STAR*Map project, among local and state agencies. He has also fostered the participation of private sector firms in the GDC, in the furtherance of public projects.

Grant Garrison, GIS Program Manager
Mr. Garrison has been a GIS analyst for ten years and is skilled in nearly all aspects of GIS. He is an experienced programmer in VB and VB Script and has high levels of skill in ArcGIS, ArcSDE, many ancillary ESRI software products, and specification/use of aerial orthoimagery and other remote sensing data. He is responsible for the management of Data Services' GIS technical staff and directs the ongoing maintenance of *STAR*Map*, seven rural county 911 maps and is the primary GIS technical liaison with local governments and the State of Texas.

Dr. Lu-Chia Chuang, Oracle DBA/GIS Analyst
Dr. Chuang is H-GAC's Oracle database administrator for GIS and other Oracle-dependent functions within the agency, such as financial applications. He is also a skilled GIS Analyst and was one of the principle architects of the *STAR*Map model*. He is an experienced IMS site developer, with significant abilities in the following areas:

- **GIS:** ArcGIS Desktop 9, ArcSDE 9, ArcIMS 9, MapObjects 2.0, ArcView 3.x, Arc/Info Workstation, ArcObjects Programming with VBA, ArcXML
- **Programming Languages:** Visual Studio.NET, ASP.NET, ASP, HTML, Javascript, Visual Basic, C#, C, C++, Java, FORTRAN, Pascal
- **Databases:** Oracle 8i, Oracle 9i, SQL Server 2000, Microsoft Access XP

Ms. Tanya Nguyen, Network Administration Program Manager
Ms. Nguyen is a former GIS Analyst who has served as H-GAC's Network Administration Manager for the past ten years. Having a strong background in GIS, she and her staff are familiar with, and sensitive to, the hardware, software and security issues unique to GIS implementations.

Ms. Wenge Fu, GIS Analyst
Ms. Fu is responsible for STAR*Map maintenance, and works with members of the Geographic Data Committee, to review and approve edits to the map. She effected more than 28,000 edits, in 2003 and nearly 85,000 in 2004. She also works with organizations' representatives to resolve editing conflicting edits, when they arise.

PART III

Regional Geographic Data Network: *The Client Side*

Harris County Public Infrastructure Department, Engineering Division

Contributed by Andre C. Bally, Manager, HCPID CAMS Operations

BACKGROUND

The Engineering Division of the Harris County Public Infrastructure Department (HCPID Engineering) has been a member of the Houston-Galveston Area Council's (H-GAC), Geographic Data Committee (GDC), since 1998. In November of that year, HCPID Engineering implemented a Geographic Information System (GIS), and arranged to have their GIS Coordinator receive preliminary training by working at H-GAC, making edits to the *STAR*Map*. Since then, HCPID Engineering has been a member of the GDC and voluntarily contributes the continuing maintenance of *STAR*Map* through an annual fee.

POLITICAL ENVIRONMENT

Harris County has several departments which have GIS implementations including the Harris County Flood Control District, Harris County Health Department, Harris County Tax Office, Harris County Information Technology and, even within HCPID Engineering, there are two separate GIS implementations. Some, but not all of the groups, are members of the GDC. All of the groups do promote their own programs to meet their specialized goals. It is important to this discussion to realize the fragmentation of Harris County's GIS and understand that currently there is very little coordination between its diverse groups. An attempt is underway to better coordinate the individual GIS interests through the revitalization of the Harris County GIS Task Force, (a GIS Users Group that was established in 1998). It is the belief of HCPID Engineering that H-GAC, the GDC and the Regional Geographic Data Network will provide a more effective model and methodology to accomplish this coordination effort. HCPID Engineering also expects to benefit from the "substantial and meaningful improvements to data quality".

BUDGET

Harris County's fiscal year runs from March 1st through February 28th and has proven to be slightly out of sync with other area agencies. It has been extremely difficult to anticipate expenditures for the regional efforts in the development of a yearly budget within this staggered cycle. Justification for approval for funding for a project outside the scope and jurisdiction of the Engineering Division's scope has also been a challenge. However, the proven savings generated by these cost-sharing efforts are significant, so requests for funding for these efforts are becoming more palatable. The initial

installation of the *GO! Sync* application was done as a pilot project through a licensing agreement coordinated and paid for by H-GAC, which required no immediate financial expenditures on the part of HCPID Engineering. The system has been tested and proven successful and because of this coordinate effort the funds for the client side license will be made available.

IMPLEMENTATION

Currently HCPID Engineering is transitioning from an ArcView shape file based data structure toward an ArcGIS geo-database format. Two workstation licenses of ArcGIS ArcInfo 9.0 and one ArcGIS ArcView 9.0 have been acquired and implemented. The initial development will be with a personnel geo-database and an assessment is underway to determine the feasibility of implementing ArcSDE with a MircoSoft SQL Server foundation. H-GAC has installed and configured the *GO! Sync* client side editing license on one of the ArcGIS ArcInfo workstations. Using the ArcInfo, ArcMap editor, HCPID Engineering has successfully made edits to the *STAR**Map on their personnel geodatabase version and synchronized it with the master version at H-GAC. HCPID Engineering has also contributed a regional parks dataset for the pilot project.

IMMEDIATE BENEFITS

By participating with this regional effort HCPID Engineering will have an offsite backup of its authored geo-database. The geo-database will also have an increased number of GIS users that can critically review the quality of the data. There is a tremendous cost savings by leveraging the existing investment in the ArcGIS 9.0 product and minimizing the client side interface costs. HCPID Engineering also will have immediate access, in near real time, to regional data sets authored and maintained by participating agencies.

HARRIS COUNTY GIS

Of the many GIS Groups within Harris County, its Information Technology Center's (ITC) Justice Information Management System (JIMS), and the Harris County Flood Control District have committed to implementing a client side interface. These GIS groups will be able to provide data relating to area jurisdictions boundaries as well as flood zone data, channel data, watershed data and much more. By having a repository for common data coordinated by H-GAC, Harris County will be able to better coordinate its own GIS.

HCPID PROJECT PERSONNEL

Andre C. Bally, Manager CAMS Operations
Mr. Bally manages operations of Harris County's Asset Management System and supervises the GIS and Asset Log Groups. He has been a member of Houston-Galveston Area Council's Geographic Data Committee for six years. His twenty-five years experience with Harris County has also given him a unique insight into the internal workings of the county and his last six years as GIS Coordinator for Harris County Public Infrastructure Department's Engineering Division have enabled him to embrace the vision of a Regional Geographic Data Network.

Samuel Garcia, GIS Coordinator
Mr. Garcia is the new GIS Coordinator for Harris County Public Infrastructure Department's Engineering Division. He has programming experience in a variety of languages, and is skilled with ArcGIS, ArcIMS and database architecture. He will be managing the implementation of the *GO! Sync* application, the associated geodatabase, as well as coordinating the various data sets contributed to the regional effort.

PART IV

Tadpole Technology: *The Vendor and Products*

Contributed by Susan Park, Product Manager, Tadpole Technology

The business of Tadpole Technology is to securely Web-enable and extend enterprise knowledge and systems without the need to change existing applications, files or IT infrastructures. Deployed across an enterprise network, the Tadpole Group's software solutions enable businesses to maximize real-time communications, both within the enterprise and beyond, to customers, suppliers and business partners. Tadpole's solutions are deployed within government, in the private sector and among utilities. Tadpole Technology Group's subsidiaries are based in Cambridge, Edinburgh, and Bristol (UK) The US office are located in Carlsbad, and Irvine, California.

Tadpole has filled a need within the ESRI community by providing a data management solution for ArcGIS users. Tadpole has developed a suite of products based on experience gained from over 12 years of solving problems related to deploying GIS data to the field. Tadpole Technology has built its solutions on ESRI technology, providing a seasoned approach to simplifying a difficult problem. We have built our solutions in ArcObjects and we are committed to integrating any new ESRI functionality into our suite of products, while still adding value for our customers.

Tadpole's business is dependent on adopting and embracing new trends and technology. The company is dedicated to the management of GIS across the enterprise. The following products support this goal:

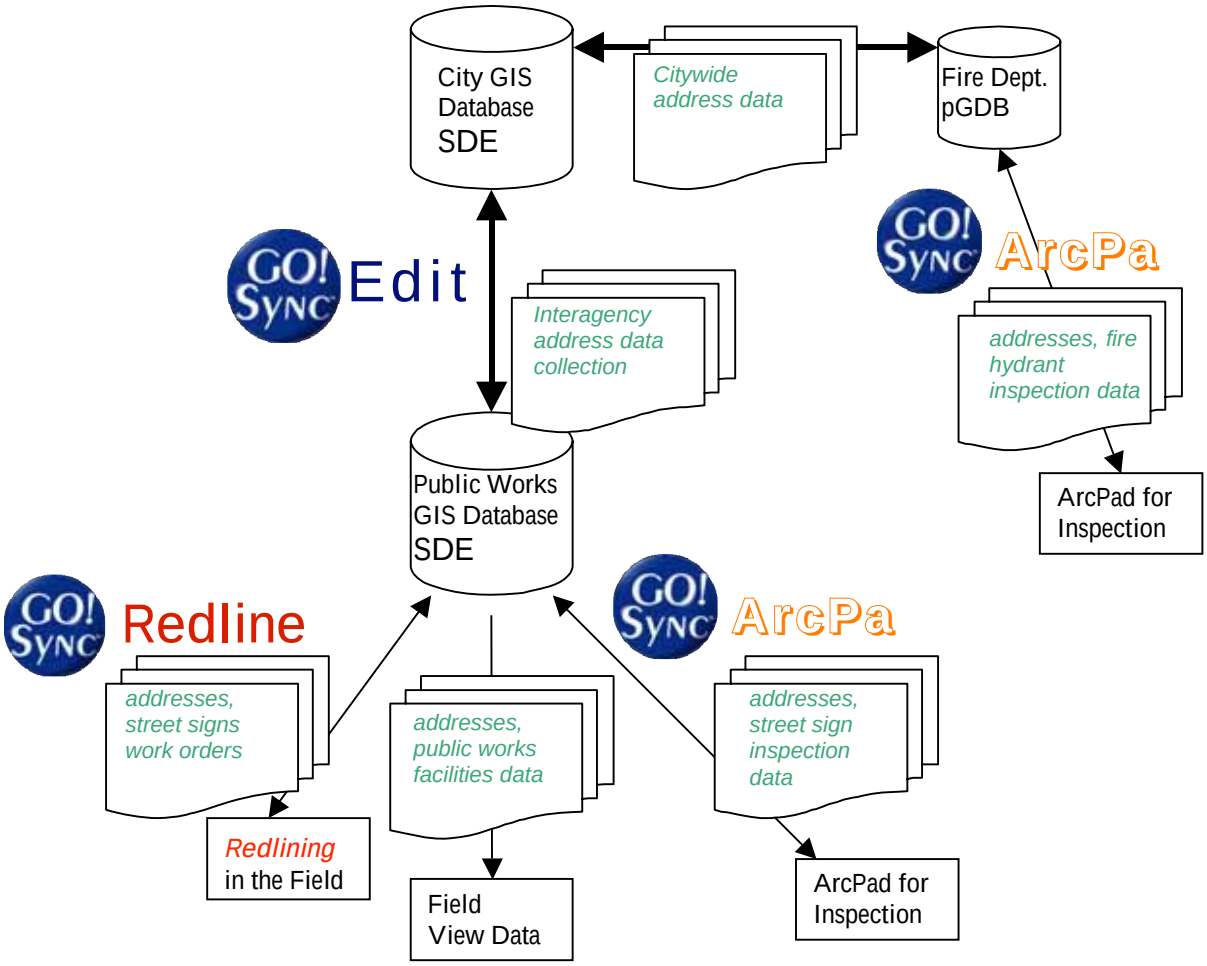
GO! Sync (View) – One-way broadcast of just the "changed" data between Personal GeoDatabase and SDE.
GO! Sync (Redline) – A smart way to create and manage field sketches. Leveraging ArcGIS Engine, GO! Sync (Redline) maintains many of the usability factors common with the paper map approach, including drawing on the map for sharing corrections, work related drawings, or personal notes.
GO! Sync (Edit) – Bi-directional synchronization that manages data between SDE and Personal GeoDatabases. A modular tool built on ArcObjects, it is designed to address the complex issues of data sharing.
GO! Sync (ArcPad) – Automates and streamlines GIS data synchronization between SDE and ArcPad.

An Enterprise Scenario Example
GO! Sync (Edit) to manage interagency data sharing of centerline and address data at the City GIS SDE server. Each organization can submit changes and edits that they see need to be corrected in the database. These changes are managed by a data owner. The data quality and reliability will be improved by this process.

The Public Works department receives nightly updates of the centerline and address data. They view this data with their facility data. The facility, work order, centerline and

address data is sent to field units that view it to find facilities. The field crews can add notes on the work order, add notes for map corrections to be synchronized up to an administrator for review using GO! Sync (Redline). The map corrections, if approved, are synchronized beyond the Public Works department, into the City database for distribution to all the other departments. GO! Sync (Redline) enables organization to take valuable data gathered first hand by field personnel and integrate that data into the citywide GIS to improve the accuracy of the GIS. The Public Works department can also send the citywide centerline and address data out for inspections in ArcPad.

The Fire Department can use the centerline and address data displayed with building, landbase and fire hydrant data for Fire Hydrant inspections in ArcPad. Using GO! Sync (ArcPad), field personnel can update relevant features and synchronize that data back to the Fire Department.


City GIS Database SDE
Citywide address data
Fire Dept. pGDB
GO! Sync
Edit
Interagency address data collection
GO! Sync
ArcPa
addresses, fire hydrant inspection data
ArcPad for Inspection
Public Works GIS Database SDE
GO! Sync
Redline
addresses, street signs work orders
Redlining in the Field
addresses, public works facilities data
Field View Data
GO! Sync
ArcPa
addresses, street sign inspection data
ArcPad for Inspection